

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE

## REPORT DOCUMENTATION

AD-A231 444

oved  
'04-0188

1a. REPORT SECURITY CLASSIFICATION Unclassified		1b.	
2a. SECURITY CLASSIFICATION AUTHORITY		3. DISTRIBUTION/AVAILABILITY OF REPORT Approved for public release; distribution unlimited	
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE			
4. PERFORMING ORGANIZATION REPORT NUMBER(S) PL-TR-91-2010		5. MONITORING ORGANIZATION REPORT NUMBER(S)	
6a. NAME OF PERFORMING ORGANIZATION Geophysics Directorate, Phillips Laboratory	6b. OFFICE SYMBOL (If applicable) LID	7a. NAME OF MONITORING ORGANIZATION DTIC SELECTED FEB 04 1991 B D	
6c. ADDRESS (City, State, and ZIP Code) Hanscom AFB Massachusetts 01731-5000		7b. ADDRESS (City, State, and ZIP Code)	
8a. NAME OF FUNDING/SPONSORING ORGANIZATION	8b. OFFICE SYMBOL (If applicable)	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER	
8c. ADDRESS (City, State, and ZIP Code)		10. SOURCE OF FUNDING NUMBERS	
		PROGRAM ELEMENT NO	PROJECT NO
		61102F	2310
		TASK NO	WORK UNIT ACCESSION NO
		G3	20
11. TITLE (Include Security Classification) Isotope Studies and Energy Dependences of Rate Constants for the Reaction of $O^- + N_2O$ at Several Temperatures			
12. PERSONAL AUTHOR(S) Robert A. Morris*, A.A. Viggiano, John F. Paulson			
13a. TYPE OF REPORT Reprint	13b. TIME COVERED FROM TO	14. DATE OF REPORT (Year, Month, Day) 1991 January 23	15. PAGE COUNT 2
16. SUPPLEMENTARY NOTATION *Air Force Geophysics Scholar - Reprinted from Nonequilibrium Effects in Ion and Electron Transport, ed. J.W. Gallagher et al., Plenum Press NY 1990			
17. COSATI CODES		18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)	
FIELD	GROUP	SUB-GROUP	
		Ion-molecule reactions, Isotope exchange, Internal energy effects	
19. ABSTRACT (Continue on reverse if necessary and identify by block number)			
Abstract: Rate constants for the reaction $O^- + N_2O$ were measured using a temperature variable selected ion flow drift tube apparatus. The rate constants depend only upon total energy, not upon the form of that energy, i.e., whether internal or translational. The pure temperature dependence of the rate constants is $T^{-0.5}$ . The dominant product channel is $NO^- + NO$ .			
20. DISTRIBUTION/AVAILABILITY OF ABSTRACT <input type="checkbox"/> UNCLASSIFIED/UNLIMITED <input checked="" type="checkbox"/> SAME AS RPT. <input type="checkbox"/> DTIC USERS		21. ABSTRACT SECURITY CLASSIFICATION Unclassified	
22a. NAME OF RESPONSIBLE INDIVIDUAL John F. Paulson		22b. TELEPHONE (Include Area Code) (617) 377-3124	22c. OFFICE SYMBOL LID

ISOTOPE STUDIES AND ENERGY DEPENDENCES OF RATE CONSTANTS FOR THE REACTION  
 $O^- + N_2O$  AT SEVERAL TEMPERATURES

Robert A. Morris\*, A. A. Viggiano and John F. Paulson

Ionospheric Physics Division  
Geophysics Laboratory  
Hanscom AFB, MA 01731-5000

Rate constants for the reaction  $O^- + N_2O$  were measured using a temperature variable-selected ion flow drift tube (SIFDT) instrument. The reaction was studied as a function of kinetic energy at four temperatures: 143, 196, 295, and 515 K. The product branching ratios of the reactions  $^{16}O^- + ^{14}N^{15}N^{16}O$  and  $^{18}O^- + ^{14}N^{15}N^{16}O$  were measured at two temperatures: 143 and 298 K.

The experiment employs a temperature variable flow tube with which to control the thermal energy of the reagents as well as an electric drift field to increase independently the kinetic energy of the ionic reactant. This permits fixing the overall center of mass collision energy while varying the relative contributions to that collision energy from the thermal energy of the reagents (due to temperature) and from the additional ion kinetic energy due to the electric field of the drift tube. Thus, reactions of monatomic ions (no internal modes) can be probed for the effects of the internal energy of the reactant neutral (Viggiano et al., 1988).

Figure 1 shows the rate constants for the reaction  $O^- + N_2O$  plotted versus center-of-mass collision energy. The energy dependences of the rate constants measured at different experimental temperatures fall on the same curve within experimental uncertainty. Therefore, there appears to be little or no effect of the internal energy of the  $N_2O$  reactant on the rate constant. In other words, the rate constant appears to depend only upon total energy and not on the particular type of energy. The pure temperature dependence of the rate constant is shown in the figure as a solid line and can be represented as  $T^{-0.5}$ .

\* Air Force Geophysics Scholar

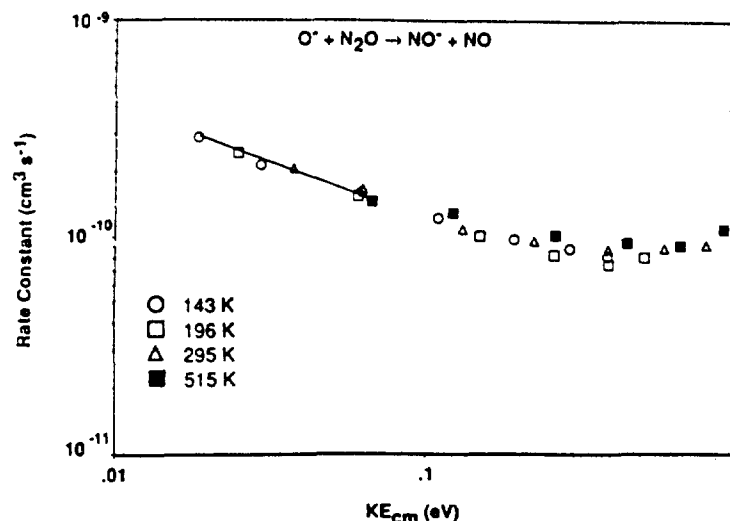


Fig. 1. Rate constants for the reaction  $O^- + N_2O$  plotted as a function of center-of-mass kinetic energy.

The dominant product channel at the energies accessible in the experiment is that producing  $NO^- + NO$ . For the reaction of  $O^-$  with  $^{14}N^{15}NO$ , the ratio of the ionic products,  $^{14}NO^- / ^{15}NO^-$ , approached unity at zero  $^{14}N^{15}NO$  flow rate but decreased below unity with increasing  $^{14}N^{15}NO$  flow rate. It is suggested that the decrease is due to the secondary reaction  $^{14}NO^- + ^{14}N^{15}NO \rightarrow ^{15}NO^- + ^{14}N^{14}NO$ , which we have measured to occur with a rate constant of  $1 \times 10^{-11} cm^3 s^{-1}$ .

For the reaction  $^{18}O^- + ^{14}N^{15}N^{16}O$ , the  $O^-$  exchange product,  $^{16}O^-$ , was observable and represents a major product channel along with that producing  $NO^- + NO$ . All four  $NO^-$  isotopic products were observed:  $^{14}N^{16}O^-$ ,  $^{15}N^{16}O^-$ ,  $^{14}N^{18}O^-$ , and  $^{15}N^{18}O^-$ . The secondary reactions of both the exchange product  $^{16}O^-$  and the various  $NO^-$  products with  $N_2O$  complicate the interpretation of the product spectra. Computer modeling of the coupled reactions and the resulting product branching ratios measured at the two experimental temperatures will be discussed.

#### REFERENCES

Viggiano, A. A., R. A. Morris, and J. F. Paulson, 1988, J. Chem. Phys. 89, 4848; *ibid.* (in press, 1989).



Accession For	
NTIS	TRA&I <input checked="" type="checkbox"/>
DTIC	TAB <input type="checkbox"/>
Unannounced <input type="checkbox"/>	
Justification _____	
By _____	
Distribution/ _____	
Availability Codes	
Dist	Avail and/or Special
A-1	20